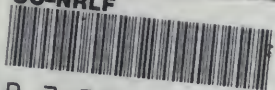


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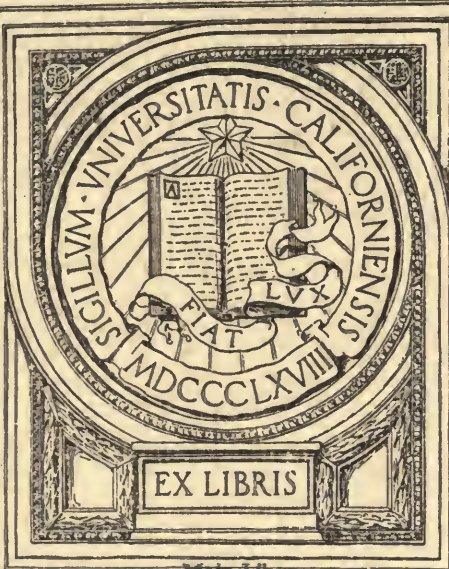


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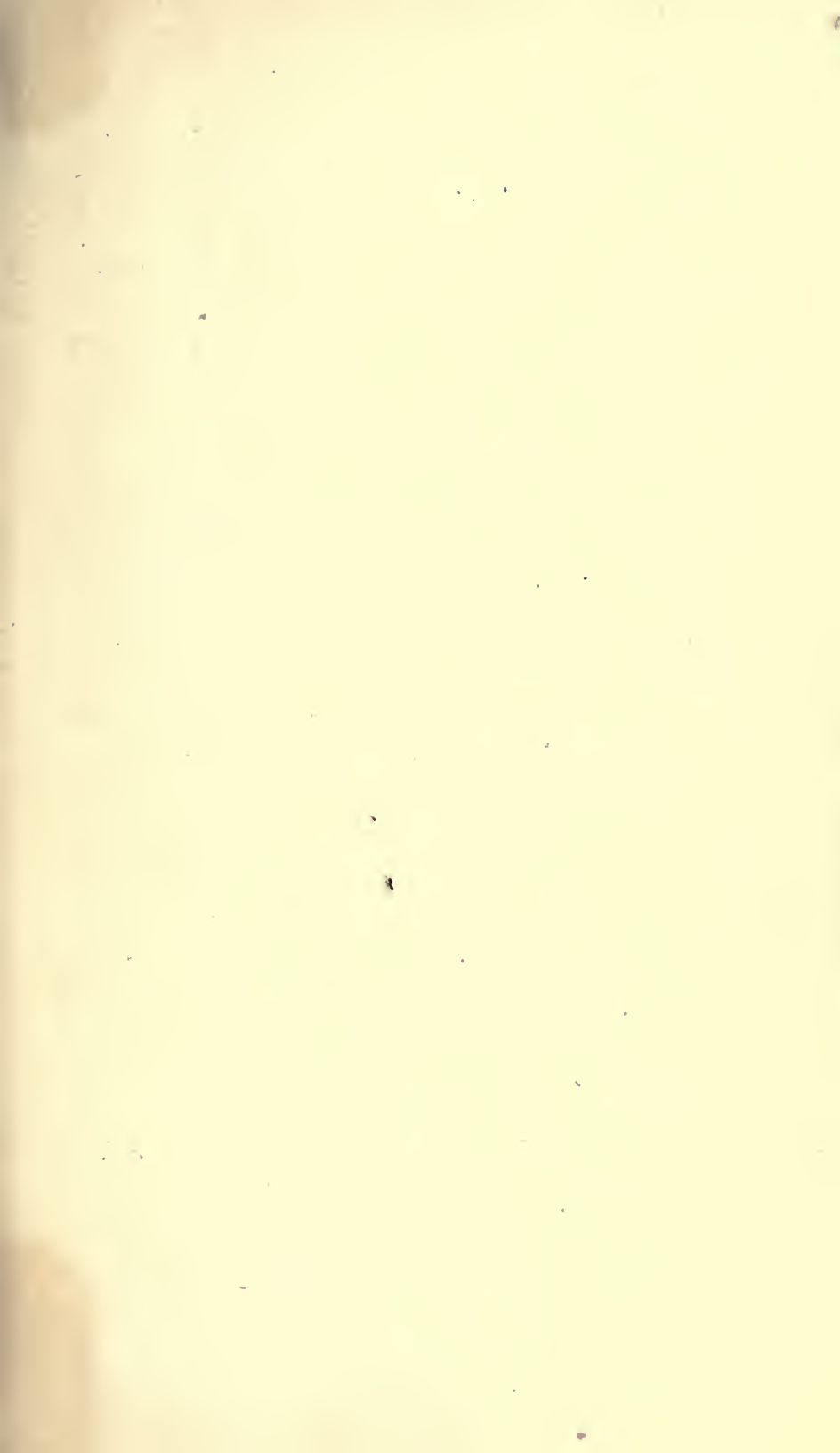
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MILTON WHITNEY, Chief of Bureau.

CITY STREET SWEEPINGS AS A FERTILIZER.

BY

J. J. SKINNER AND J. H. BEATTIE,

Scientists in Soil Fertility Investigations.



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BUREAU OF SOILS.

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CITY STREET SWEEPINGS AS A FERTILIZER.

This bureau has many requests for information in regard to the value of street dust and street sweepings as fertilizing material, both from truckers and gardeners and from officials of large cities interested in the best means of disposing of city waste.

The débris which is collected from the streets of cities is commonly used as fertilizing material, being sold to near-by gardeners, truckers, and farmers, its rather low cost making it particularly attractive. The main object of the city official is to dispose of the material, and in some cases it is burned and in others it is hauled to a dumping ground and used as filling material.

There is some variation in the character of the material collected from the streets of different cities, depending on the nature of the industries, the kind of paving material used, and the character of traffic on their streets, yet on the whole the collections from sweepings are very similar and consist chiefly of animal manure, leaves, dirt, and trash, such as paper, fruit skins, particles of coal, etc. The sweepings may contain also finer particles of the paving substance and some oily material dropped from vehicles. This is especially true at the present time, when the use of power vehicles for pleasure and business is so extensive. The effect of the sweepings on crops, especially when used continually year after year on the same field, is a subject of much interest and has caused considerable speculation.

This article deals with an investigation of the street sweepings of one of the larger cities. The material was studied from the point of view of its organic and inorganic constituents, and through cultural tests, by means of which its effect on plant growth was observed.

CHEMICAL EXAMINATION FOR MINERAL SALTS.

Three samples of the sweepings were examined. Sample No. 1 consisted of the débris secured by hand sweeping with a brush, sample No. 2 was that secured by sweeping with a machine, and sample No. 3 was the decomposed débris from a dump pile which had been accumulating for some length of time. There was no apparent physical difference between sample No. 1 and sample No. 2, both being composed mostly of the raw horse manure. Sample No. 3 consisted principally of well-decomposed horse manure.

The chemical analysis of the three samples is given in Table I, the results being stated in percentage of dry material. The analyses were made by Mr. J. G. Smith, of the Laboratory of Physical and Chemical Investigations.

TABLE I.—*Analyses of street sweepings.*¹

Sample No.	Description.	Nitrogen (N).	Potash (K ₂ O).	Phosphate (P ₂ O ₅).
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1	Hand sweepings.....	1.34	0.71	1.03
2	Machine sweepings.....	.86	.55	.55
3	Decomposed sweepings.....	.60	.56	.60

¹ A more extended table of the analyses of such street sweepings made in 1898 is found in Bulletin 55, Division of Chemistry, U. S. Department of Agriculture. The results, stated in percentages of the original moist material, varied in the different samples from 0.17 to 1.18 for N, 0.01 to 0.16 for P₂O₅, 0.08 to 0.50 for K₂O and 6.2 to 52.3 for moisture.

This table shows each of the samples to contain appreciable amounts of nitrogen, potash, and phosphate, sample No. 1 being somewhat higher in each of these fertilizing constituents. Stable manure, as determined from an average of a large number of samples, contains about 1.6 per cent of nitrogen, 1.5 per cent of potash, and about 1 per cent of phosphoric acid, the figures being based on dry material. Comparing these amounts with those contained in ordinary horse manure,¹ it will be seen that the content of nitrogen, potash, and phosphate is higher in the latter. The lower result might be expected, as the sweepings are not all horse manure, but contain considerable foreign material, aside from the fact that they are frequently subjected to leaching by rain.

EFFECT ON GROWTH.

The efficiency of street sweepings and other manures of this nature as fertilizing material should not be judged merely by the percentage of mineral salts which they contain. The organic material itself has an important bearing on the question, as it may be of such a nature or contain such constituents as to cause it to have either a beneficial or a harmful effect on soils.

Experiments were undertaken to test the effect of sweepings on crops, by growing plants in soil to which the sweepings had been added. In these experiments a specially constructed paraffine wire pot,² possessing certain advantages over the ordinary clay pot, was used.

To test the effect of sweepings on soil, wheat was grown in the paraffine wire pots for one month. The soil used in the test was a clay loam. The soil was divided into four portions. To three of these was added a sample of one of the three types of sweepings, while to the fourth good stable manure was added, in order that a comparison might be made. These cultures were checked against the growth

¹ Storer, F. H., *Agriculture in Some of Its Relations with Chemistry.*

² For description of method see Circular No. 18, Bureau of Soils.

in untreated soil. The sweepings and manure were used at the rate of 5 tons per acre. The tests were conducted in a greenhouse, where the conditions of temperature and moisture could be controlled. When the plants had grown for 30 days they were cut and the green weight recorded. Three pots were used for each treatment, six plants in each pot.

TABLE II.—*Growth of wheat in soil treated with street sweepings and stable manure.*

Treatment.	Green weight.	Increase.
	Grams.	Per cent.
Soil untreated.....	1.708	
Soil+hand sweepings (sample No. 1).....	2.240	31
Soil+machine sweepings (sample No. 2).....	1.880	10
Soil+decomposed sweepings (sample No. 3).....	1.800	5
Soil+stable manure.....	2.500	46

The figures in this table show the sweepings to be beneficial, especially sample No. 1. In this case the growth was improved 31 per cent. In sample No. 2 there was a gain of 10 per cent, and in sample No. 3 a gain of 5 per cent in growth. The beneficial effect of stable manure was, however, much greater than that of any of the three sweepings; the growth in this case was increased 46 per cent, which seems to indicate that while the sweepings are beneficial they are not as efficient as good stable manure.

Another test was made in which corn was grown in the soil treated with street sweepings and stable manure, the manurial treatments and general methods being the same as in the first experiment. Results which substantiate those obtained in the latter were secured. The green weight is given in the table below.

TABLE III.—*Growth of corn in soil treated with street sweepings and stable manure.*

Treatment.	Green weight.	Increase.
	Grams.	Per cent.
Soil untreated.....	3.700	
Soil+hand sweepings (sample No. 1).....	4.710	27
Soil+machine sweepings (sample No. 2).....	4.160	12
Soil+decomposed sweepings (sample No. 3).....	3.440	— 8
Soil+stable manure.....	4.950	34

There was an increased growth with samples No. 1 and No. 2, but a decrease where sample No. 3 was used. Again the stable manure had a more beneficial effect than the best of the sweepings. The growth is shown in the cut in figure 1.

Another culture test was made, using a vegetable (radish) as the plant on which to test the effect of the street debris. The growth of plants in this experiment is shown in the cut in figure 2. Pot 1 is the untreated soil, pot 2 is treated with the machine sweepings (sample No. 2), pot 3 is treated with the hand sweepings (sample No. 1), pot 4 is treated with the decomposed sweepings (sample No. 3),

and pot 5 with stable manure. The illustration shows again that the sweepings are beneficial, the plants in pots 2, 3, and 4 being larger than in the untreated pot 1. Pot 4, which contains the soil treated with decomposed sweepings, has smaller plants than any other except the check. It will be recalled that this treatment showed the least effect also in the case of wheat and corn. Pot 5, which is treated with stable manure, has produced the largest growth, which again shows that the sweepings are not as helpful as good stable manure.

EXAMINATION FOR MINERAL OIL.

The sweepings, as was pointed out, are apt to contain lubricating oils and fine particles from the decay of the paving materials, which may be a factor in determining their usefulness as a fertilizer material. In order to study this point the three samples were repeatedly



FIG. 1.—Effect of street sweepings and stable manure on corn. (1) Soil untreated; (2) soil + stable manure; (3) soil + sweepings No. 1; (4) soil + sweepings No. 3; (5) soil + sweepings No. 2.

extracted in an extraction apparatus with petroleum ether until the solvent was no longer colored. The fatty material was saponified with alcoholic potash and the amount of mineral oil extracted by petroleum ether determined. Sample No. 1 contained 1.7 per cent, sample No. 2 contained 2 per cent, and sample No. 3 contained 2 per cent of the crude mineral oil. This high content of mineral oil suggests the possibility of the recovery of low-grade lubricating oil from city street sweepings, especially in those cities which have considerable automobile traffic.

EFFECT OF THE OIL ON GROWTH.

The effect of the oil extracted from the sweepings on growth was tested with wheat plants. The young wheat seedlings were grown in distilled water and nutrient solution cultures. Fifty milligrams of oil from each sample was put in the culture bottles containing 250 c. c. of solution. The oils from all of the samples were harmful to growth,

the roots as well as the tops being affected. Oils from samples No. 1 and No. 2 reduced the growth of wheat 10 per cent in the case of the distilled water cultures, and the oil from sample No. 3 reduced the growth 20 per cent. In a solution containing the nutrient salts the oils used in the same amount from sample No. 1 reduced growth 6 per cent; from sample No. 2, 7 per cent; and from sample No. 3, 11 per cent.

TEST OF SWEEPINGS AFTER OIL WAS EXTRACTED.

The sweepings from which the oil had been extracted were next tested as to their effect on growth. The petroleum ether was evaporated completely from the manure by allowing it to stand in the open for a week or more. The same kind of soil was used as in the



FIG. 2.—Effect of street sweepings and stable manure on radishes. (1) Soil untreated; (2) soil + sweepings No. 1; (3) soil + sweepings No. 2; (4) soil + sweepings No. 3; (5) soil + stable manure.

previous experiments and the extracted sweepings were added to portions of the soil at the rate of 5 tons per acre. Treatments with stable manure, extracted with petroleum ether and also in its natural condition, were included in the test as a means of comparison with the samples of sweepings. The plants were grown in the paraffin pots for 30 days, then the green weights were taken. Three pots were used for each treatment. The growth is given in Table IV.

TABLE IV.—*Effect of street sweepings after being extracted with petroleum ether.*

Treatment.	Green weight of—	
	Wheat.	Radish.
	<i>Grams.</i>	<i>Grams.</i>
Soil untreated.....	1.910	3.700
Soil+hand sweepings, extracted (sample No. 1).....	2.270	5.400
Soil+machine sweepings, extracted (sample No. 2).....	2.270	5.700
Soil+decomposed sweepings, extracted (sample No. 3).....	2.190	5.200
Soil+stable manure, extracted.....	2.260	5.800
Soil+stable manure, natural.....	2.270	5.700

An examination of the figures in the table shows that the sweepings and stable manure had about the same efficiency in causing increased growth. This is true with both the grain and the vegetable crop.

The oil was also extracted from the sweepings by using ether as the solvent, and the sweepings afterwards tested in soils. This test also showed that the sweepings were practically as good as the stable manure.

It will be recalled that the effect of the unextracted sweepings was not nearly so good as the effect produced by the stable manure. In other words, after the oil was removed from the street sweepings their action was practically the same as that of the stable manure. That the oil is the deleterious constituent of the sweepings is also borne out by the fact that the oil itself when added to culture solutions in which plants were growing markedly reduced their growth.

The application of street sweepings to soils will undoubtedly have a beneficial effect and be a factor in building up the land. The possible danger of a harmful effect from the oily substance which it contains must, however, be considered. If the oil could be economically extracted this danger would be averted. The oil in the débris for the first year or two may not have any effect, but a continuous application to a field year after year may eventually impair its productiveness, unless through drainage or other natural agencies the oily material is drained off or changed. In some localities this is probably the case, as the use of such material is still said to be effective, although it has been applied for a number of years. No very definite field information on this point is, however, at hand. In this connection attention must be called to the fact that the presence of an unusual amount of oil in such street sweepings has been the result of automobile traffic, and hence appears only in recent years as an appreciable factor in the use of street sweepings as fertilizer, and it is not improbable that the amount of oil will even further increase in the next few years.

Aside from the physiological action of the oily material here mentioned, there are probably other more strictly physical effects, due to the coating of soil particles and consequent interference with normal moisture movement and solubility of the mineral soil constituents.

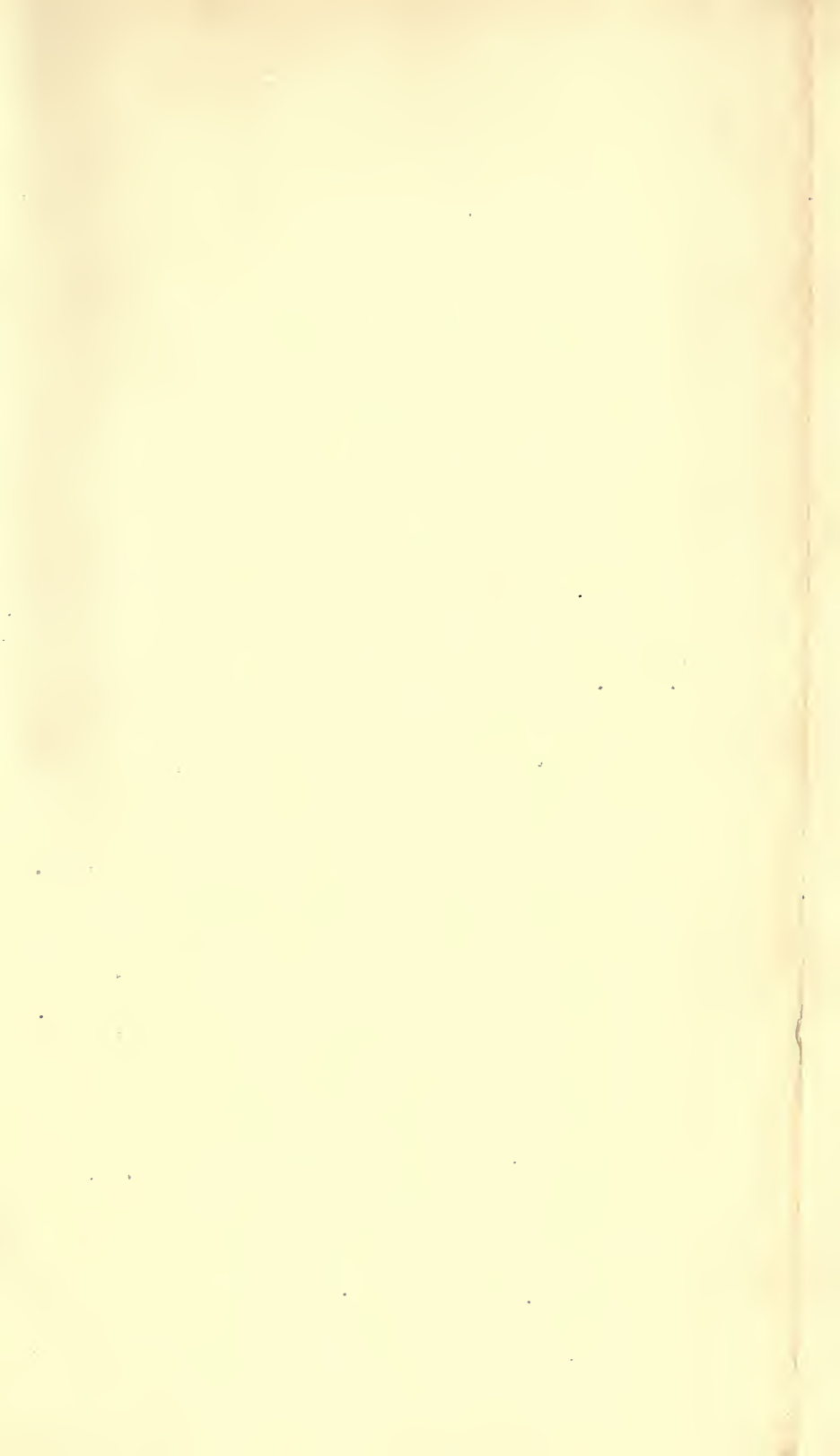
Vegetable or animal oils undergo changes in soils under the influence of soil organisms, but so little is known concerning the action of organisms on the strictly hydrocarbon oils that no statement concerning the possible disappearance or change of this oil in street sweepings can be made.

Approved:

JAMES WILSON,

Secretary of Agriculture.

Washington, D. C., March 24, 1912.





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